SHORTAGES OF VEGETABLE OILS

AND

SOLUTIONS

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Man derives his energy from three major sources: carbohydrates, oils and fats, and proteins. Oils and fats are essential components of diet because these are the most important and concentrated form of energy, furnishing about 9 Calories of energy against 4 Calories per gramme provided by carbohydrates and proteins. Besides, being an important source of energy fats and oils also serve as carriers of fat-soluble vitamins i.e. A, D, E and K which are essential for proper maintenance of health.

Oils provide essential fatty acids like linoleic acid which are needed for human health. It has now been established that dietary linoleic acid plays an important role in the etiology of heart diseases and that a high level of consumption of this unsaturated acid is desirable. Essential fatty acids have recently been reported to regulate a large variety of vital physiological functions such as fertility, blood pressure, smooth muscle contraction and transmission of information along the nerves from brain.

Fats and oils also find their use in the production of baked foods such as bread, biscuits, cakes and cookies. In frying foods, oils and fats not only act as efficient medium for transfer of heat, but also help in preserving the food and in improvement in its flavour and texture.

The main sources of dietary oils and fats in Pakistan are the hydrogenated vegetable oils, mustard seed oil, animal fat, butter and butter oil, among which vegetable oils are the major contributors. The per capita consumption of vegetable oils is about 6.85 kg per annum which is quite low as compared to the developed countries where it ranges between 10 to 11 kg. Presently the annual consumption of vegetable ghee in Pakistan is about 577,000 tonnes which is expected to increase upto 800,000 tonnes during the next few years due to increase in population and enhanced per capita consumption with the increase in family income.

Although per capita consumption of vegetable oil in Pakistan is low, the domestic supply of this most essential commodity has not been adequate and Pakistan has to import 361,000 tonnes (worth Rs.300 million) of vegetable oil per annum.

The principal oil-seed crops grown in Pakistan have been cotton seed and mustard and rape seeds (Table 1). Recently, the trend has shifted towards the introduction of other high oil-yielding crops such as sun-flower, safflower, soybean and ground-nut. Various oil-seed development programmes have been launched by government agencies to boost up production of edible oils in the country. These efforts will prove successful only if our research and development endeavours are geared towards total utilization of the oil-seeds. Edible oil is only a by-product of the oil-seed processing industry while the major products are oil-seed cakes and oil-seed hulls.

Oil-seed cakes are nutritionally rich sources of protein, but invariably contain toxic substances and high fibre contents. At present a small portion of mustard/rape seeds is being utilized in cattle or poultry feed, whereas decorticated/undecorticated cotton-seed cakes are being fully consumed. Development of cheap methods of detoxification of soybean, sun-flower, safflower and other high oil-yielding seeds, would definitely help in boosting up production of the seeds which will result in an increased supply of vegetable oil.

Some of the oil-seed cakes have a very balanced amino acid make-up and can be incorporated into Pakistani dishes after removal of excess fibrous matter and toxic and antinutritional factors. Thus an additional source of food can be made available from a non-food item.

In view of the renewed interest of the Government of Pakistan in attaining self-sufficiency in the production of oil-seeds in the country, popular varieties of various oil-seeds have been analysed to assess their nutritional and antinutritional factors. Research and development activities have also been directed towards elimination of antinutritional and toxic factors present in the cakes without adversely affecting quality of the protein.

COTTON SEED

Cotton seed is the major agricultural crop of Pakistan and is mainly cultivated for staple fibre. It is grown mostly in Punjab and Sind. The area under cultivation of this crop has increased considerably during the last decade. However, its production is subject to the vagaries of weather conditions and the market trend prevailing in the country and the export market. During the year 1981-82 total area under the cultivation of this crop was 2100 thousand hactares with an annual production of 873.95 thousand tonnes of cotton seeds (Table-I). Contribution of various oil-seeds to domestic edible oil production in 81-82 is given in Table-II.

Cottonseed consists of 36 % hulls, 55.5 % kernels and 8.5 % linters. The major economic component of the seed is oil which occurs in quantities (upto 20 %) approximately equal to the amount of protein (Table-III). The oil is one of the world's prime edible vegetable oils as it contains a good proportion of oleic (17 %) and linoleic (52 %) acids. The other major components of the seeds are fibrous material (26 %) and mineral matter (3.0 %).

Hulls are composed primarily of crude fibre (44 %), there is little oil (7.0 %) or protein (6.5 %) in the hulls which might have come from small amounts of kernels that could not be separated from the hulls.

Cotton seed meal consists mainly of fibrous (51 %) and proteineous (34 %) matter with little oil (8 %) and ash contents (6.5 %). However, its composition may vary from meal to meal depending upon the method of processing of cotton seeds for oil extraction. Cotton seed oil contains 52 % of linoleic acid (Table-IV) which is one of the essential fatty acids.

Toxic Factor:

Gossypol is the major toxic factor present in cotton seeds. A high proportion of it is present in the kernels (0.90 %). Cotton seed meal also contains a fair amount of gossypol which may produce toxic effects when consumed in sufficient quantities. Pulmonary oedema, loss of appetite and hemolytic anemia are some of the toxic effects attributed to gossypol after ingestion[1].

Methods have been devised to eliminate this deleterious substance from the meal. Vaccarino et al[2] used 96 % acetone as a solvent to eliminate gossypol. Acetone extraction produced an exceedingly light-coloured meal containing less than 0.03 % gossypol. Vix et al[3] developed liquid cyclone process for the production of degossypolized cotton seed flour. Fu-Kuang et al[4] reported detoxification of cotton seed meal by extraction with mixed solvent. Workers at the PCSIR, Lahore used organic solvents and inorganic salts to eliminate/reduce free gossypol from cotton seed meal. These methods, however, have not yet been developed successfully on an industrial scale due to higher processing cost and poor colour quality of the products thus obtained. Recently a comparatively cheaper semi-pilot plant process has been developed by the PCSIR. The process consists of treatment of the meal with water which results in a reduction in gossypol contents to a level as low as 0.05 % with minimum losses of soluble protein and other constituents.

Main Uses of Cotton Seeds

Almost the entire amount of cotton seed; in Pakistan is processed for the production of edible oil and cotton seed cake contributes more than 50 % towards the total edible oil production in Pakistan. A small percentage of cotton seeds produced is also used to feed cattle by the farmers. The oil is mainly used for the production of vegetable ghee and for the manufacture of soap. A little proportion of the oil is consumed as cooking oil also.

Secondary and Waste Products

1. Cotton seed cake (undecorticated cake) and meal (decorticated seed cake) are the secondary products of cotton seed processing industry and are used almost entirely as livestock feed. They fall into the class of feeds known as protein concentrate and are marketed as cake or meal.

2. Cotton seed hulls recovered during cotton seed milling are also used as roughage for livestock feeding. Cotton seed stalks are mainly used as fuel due to their poor digestibility.

Recent experiments[5] carried out at PCSIR Lahore have shown that the digestibility of hulls and stalks can be significantly improved by alkali treatment. Digestibility of hulls increased from 15.33 to 39.94 % when treated with 5 % ammonia but when autoclaved with 4 % sodium hydroxide solution the digestibility increased to 46.67 %. Digestibility of cotton stalks increased from 18.85 to 36.41 % when treated first with 0.5 % calcium hydroxide solution and then with 5 % ammonia. A three fold increase in non-proteinous nitrogen was also observed. Thus the wastes from the cotton seed plants can be converted into valuable products for livestock feeding.

3. Cotton seed flour is another usable secondary product obtained from specially processed cotton seed cake. Though not consumed in Pakistan, it is sold in developed countries as a valuable supplement for cereal flours which are normally deficient in proteins[6].

MUSTARD AND RAPE SEEDS

Mustard and rape seeds (Brassica compestris and B. napus) rank number five among the oil seeds produced in the world. They are the only seeds grown successfully in all parts of the world. The seeds are also well adopted to climatic conditions of Pakistan and have been successfully grown in various regions specially rain fed areas ("Barani"). During the year 1981-82 these were grown over an area of 520 thousand hectares with total annual production of 272.48 thousand tonnes. The seeds are good source of oil and a high quality protein. There are also some toxic factors present in the seeds. These are mainly the glucosinolates which make the oil-free meal unfit for human and animal consumption. Oxazolidenethiones and isothiocyanate from glucosinolates cause enlargement of thyroid glands (goitrogenic effect). Nitriles which are the break down products of the glucosinolates have higher toxicity than oxazolidinthions[7].

Phytic acid is another factor which has been found to be present in mustard and rape seed meal[8]. This acid forms sparingly

soluble salts with divalent ions (Zn^{++}, Ca^{++}, Fe^{++} etc.) and limits their availability to animals which results in anorexia (lack of appetite). In severe cases of toxicity a high fetal mortality is observed.

Mustard and rape seeds have been the subject of extensive investigations at the Food Technology and Fermentation Division of the PCSIR Lahore during the past decade. Detoxified high protein meal has been prepared and successfully incorporated into poultry feed and food.

Compositional data of eight different varieties of mustard seed is presented in Table V . Analysis of mustard seeds show that kernels: hulls ratio in different varieties varied between 68:32 and 61:39 (Table-VI). It can also be seen that proteins and oils are concentrated in the kernels and fiber in the hulls (Table-VI). Phytic acid is present in all the varieties and ranges from 2.7-3.2 % with an average of 3.0 % in the seed and 1.8 to 2.1 % in the kernels. Hulls contain lesser (0.9 - 1.3 %) concentration of phytic acid (Table-VII). Defatted kernel meal (phytic acid contents 2.1 %) when subjected to various treatment showed reduction in phytic acid contents (Table-VIII). The maximum reduction (96 %) being in the samples treated with one molar sodium chloride solution at pH 4.8 when meal to liquid ratio was 1:10. This treatment also resulted in a 45 % loss in protein contents in the soluble form. Seventy five percent of this soluble protein was recovered when the supernatant was subjected to steaming at 70 - 80°C (Table-VIII).

Phytic acid has been reported to be present in seeds as phytate of calcium and magnesium. Treatment with Aq. NaCl at acidic pH seems to make phytic acid soluble under these conditions and facilitates its removal.

Main Uses of Mustard and Rape Seeds

Mustard and rape seeds are mainly crushed for oil production. The oil when refined is used for edible purposes as cooking oil. Inferior qualities of oil is widely used as lubericating and cutting oil; in the manufacture of soap and for illuminating purposes.

Subsidiary Uses:

Erucic acid which is present upto 45 % in the oil can serve as a substitute of olein flotation agents.

Ozonising splitting of erucic acid yields brassylic and pelarogenic acids which have a technical significance. These acids give a product, after hydrogenation under pressure, which is suitable for manufacture of synthetic waxes and lubricants.[6]

Secondary and Waste Products

1. Mustard and rape seed meals, although good sources of protein, are unfit for human consumption and can be added in small quantities in mono and poly gastric livestock feeds due to the presence of sulphur containing compounds. Detoxification and removal of phytic acid makes it a valuable product both for animal and human consumption. Experiments conducted at PCSIR Lahore on detoxification and fortification of detoxified meal have shown promising results. Detoxified meal has been incorporated into poultry feed and in human food. About fourteen dishes commonly used in Pakistan were supplemented with 5-10 % of the detoxified meal, evaluated, and presented for consumer's evaluation and found highly acceptable.
   Detoxified mustard seed cake also replaced upto 60 % of animal protein in poultry rations without either affecting weight gain, egg laying capacity of hens, or the quality of the eggs. Mustard seed meal is often used in small quantities in compound feeds and as manure.
2. The leaves of the young mustard plants are very popular in Pakistan as green vegetable ("saag").
3. Plants are also used as fodder crop for animals.

PEANUT

Peanut is widely grown, in various countries, on about 18 million hectares with a production of about 19 million meteric tonnes of peanut annually[9]. Although ground-nut is the world's fourth most important source of edible oil and third most important source of vegetable protein meal, it is not popular among the farmers in Pakistan due to certain agronomical and economical constraints. In Pakistan peanut was introduced in 1949 firstly in Rawalpindi Division. Presently about 92 percent of total area under peanut lies in Punjab, 7 percent in NWFP and the rest is in the province of Sind. During the year 1981-82 total area under peanut cultivation was 31,250 hectares which yielded about 55,780 tonnes of peanut. In view of the plans of the PARC to boost up production of oil seeds in the country, its production is expected to be increased upto 119 thousand tonnes during the year 1982-83. The most promising varieties grown in Pakistan are "Banki" and 334. A comparison of the seed quality of these two varieties is given in (Table IX).

Peanut is mostly used as roasted nut (without shell) for table purpose. It is also used in confectionary and baked products. The seeds contain upto 47 % oil of good quality oil (Table X) and can contribute upto 9 % to the total edible oil production of Pakistan (Table II) if direct consumption of peanut in the roasted form is avoided.

In most of the countries peanut is processed into oil and meal. Meal is used as human food or animal feed. In recent years there has been a considerable interest in the development of new uses for peanut. Over 300 uses of peanut have been developed which include food, feed and industrial products[9]. These products however, have not been prepared and introduced in Pakistan because the basic material i.e. peanut cake, is not available though, there exists a considerable potential for development and innovative uses of peanut products in Pakistan.

Keeping in view the wide spread use of peanut selected varieties ("Banki" and 334) of peanut grown in Pakistan have been analysed for their proximate composition and antinutritional factors.

Peanut pod consists of shells, kernel and testa . The shell portion varies from 23 to 25 %, whereas, kernels vary from 72.5 to 73.7 % of the peanut pod. The red colored testa makes the lowest proporetion (2.5 - 2.6 %) of the seed in both the varieties (Table IX).

Proximate analysis data (Table X) indicate that oil constitutes the major (upto 61 %) portion of the kernel which is followed by the protein contents (upto 19.0 %). Hulls mainly consist of fibrous matter with lower proportion of protein and oil. Testa contains greater amount of protein (12 %) as compared with hulls. Mineral contents of different pod components vary from 1.8 to 4.8 % with the highest in the testa of 334 variety.

It has been reported[10] that eating raw peanut causes various ailments (headache, stomach distress, full-headedness etc.) which could be attributed to the presence of various deleterious factors in raw peanut. Both the varieties under study were investigated for the presence of such factors as trypsin inhibitor, phytic acid, oxalic acid and aflatoxin. Kernels of both the varieties have been found to contain 3.1 - 3.3 % phytic acid and 0.18 - 0.5 % oxalic acid. Trypsin inhibitor level in raw peanut was comparable to that present in raw soybean and it has been reported to be enough to cause significant pancreatic hypertrophy in rats[11]. Presence of aflatoxin however, was not detected in any of the varieites despite the presence of 15-18 % of moldy seeds. This seems to be due to a shorter time span between the harvest and the analysis because there had been reports of the presence of aflatoxins in peanuts stored for longer time[12].

Based upon these findings it can be concluded that peanut and its derivatives could enter into commercial competition with other oil seeds if the area under this crop is increased and yields exceed table needs of the masses.

Secondary Products of Peanuts

1. Peanut Milk:

Peanut milk and curd substitutes from peanut have long been on the market in China. These products are prepared by extracting decorticated seeds, after removing testa, with water. The water extract is neutrilized and steamed for 45-60 minutes to remove its nutty flavour and odour. The milk is finally homogenised and can be used as such or for the production of curd, "khova" or lactic cheese etc. Peanut milk, cheese spread, "Lac-Tone" (vegetable tonned milk) and low-fat-peanut flour have been developed in Pakistan by the PCSIR Laboratories Lahore.

2. Peanut Butter:

Peanut butter is prepared from roasted nuts. The roasted stock is cooled, blanched and freed from bitter principles and is ground to a butter. Some of the additives are used to improve the nutritive value and to retard rancidity. The quality is assessed largely by aroma, flavour and appearance (colour and oil separation) but spreadability, stickiness in mouth and resistance to development of rancidity are also taken into account. Peanut butter has also been successfully produced by the PCSIR Laboratories, Lahore and Peshawar.

3. Defatted Peanut Flours[6]:

Defatted peanut flours have been evaluated as additives to increase the protein contents of food such as bread and baked products. It has also been used in preparing skim and full-fat (fat added) milk-like drinks and ice-creams. The over-roasted flour has potential for use as a cocoa diluent. These flours have also been used to prepare protein isolates with protein contents of over 90 %.

4. Peanut Meal:

The residue after oil extraction can be incorporated into human food and livestock feed and is marketed in the form of cake.

SESAME

Sesame (*Sesamum indicum* L) is believed to be the earliest condiment used and the oldest crop grown for edible oil. The seed has been called the "Queen of the oil-seed crops" because of its high quality oil and oil-free meal[14].

Sesame is primarily grown in less developed tropical and sub-tropical areas of Asia, Mediterranean and South America. Its annual world production is estimated at about 2,000,000 metric tonnes which places it sixth in the line with soybean, peanut, cotton seed, sunflower and rapeseed in the family of world oil seed crops[15]. In Pakistan it is not cultivated as a commercial oil-seed crop. In 1981-82 it was planted on an area of 46,000 hectares with total productiobn of 19,000 tonnes. The lack of interest in the cultivation of sesame is attributed to the long period of maturity, tendency of the capsule to split, uneven maturity of the pod and non-availability of good quality seeds.

Sesame has good potential to be recognised as a commercial oil-seed crop because of its high oil contents and nutritious oil-free meal. Sesame oil has a pleasant flavour, mild taste and is remarkably stable due to the presence of natural antioxidant sesamol[14]. The oil finds wide applications in cooking, shortening and in pharmaceutics. The oil-free meal is a rich source of protein with unique balance of amino-acids[16]. It is extensively used in livestock feed and is also very platable to human.

Sesame seeds are very small sweet and oleaginous and are used directly as food in Pakistan. Fried sesame seeds may be mixed with sugar to form sweet meat. The seeds are also used as a garnish on speciality breads, nans, buns and rolls.

Sesame oil-free flour is comparable with other oil-seed flours. Heat treated or non-heat treated flour is lighter in colour than cotton seed, peanut or sun-flower cakes. It is more compatible with wheat flour than other oil seed flours in producing bread with good loaf volume and crumb texture. Thus nutritional and functional properties of sesame products create significant interest in sesame seed utilization. Keeping in view the nutritional qualities of sesame seed and oil, sesame seeds were included in the present studies. Three different varieties were analysed for their chemical composition and antinutritional factors.

Data reported in Table XI indicate that oil is the major constituent (52-55 %) present in all the varieties. Variety S 20 contained the maximum amount of oil (53 %) while the other varieties contained slightly lesser amount of oil. The fatty acid pattern of the oil indicated that it contained 43 % linoleic acid and 40 % of oleic acid (Table IV). Iodine number (103) indicates that oil possesses a high degree of unsaturation and is comparable with cotton-seed oil.

Protein contents of the seeds varied from 20.6 - 24 % with an average of 22.2 %. Fiber contents show slight variations 6.0 - 6.5 % among the varieties. Oxalic acid and phytic acid contents vary from 2.7 - 3.0 % and 5.1 to 5.2 % respectively.

The data reported in Table XI is based on whole sesame seed as it is difficult to separate hulls from seeds due to their extremely small size and higher oil contents. However, if the crushed seeds are first defatted by extraction with hexane it is possible to separate hulls from fine meal simply by sieving. The hulls separated in this way accounted for about 21-23 % of the whole seeds and contain larger amounts of oxalic acid, minerals and fiber (Table XI). The meal thus separated contained higher proportion of protein (50-60 %) and negligible amount of oxalic acid. Dehulling removed maximum oil from the hulls and meal and improved the nutritional characteristics of the meal by increasing the protein content and reducing oxalic acid and fiber contents. It also imparted, a glossy white appearance to the products.

Phytic acid level of dehulled defatted meal was higher than the defatted hulls indicating that most of the phytic acid was present in the inner portion of the seeds.

SUN-FLOWER

Sun-flower seed oil has been used as commercial edible oil in Europe for many years. During the past decade its production expanded by nearly 60 % placing it second in position among the vegetable oils of the world[17].

In Pakistan sun-flower was introduced in 1964 but due to poor planning and coordination in production, marketing and processing (lack of good quality sun-flower seeds and non-availability

of threshers) of crop its propagation had to be abandoned. Presently sun-flower is being cultivated under the control of Ghee Corporation of Pakistan over an area of 19,150 hectares with an annual production of 14,197 tonnes. The various varieties identified through extensive agronomic trials are sun-bred 272, IS 894, HC-1, Noor and Shams. The most promising among these varieties is shams which covers most of the cultivated area in Pakistan.

Sun-flower seeds produce highly desirable poly-unsaturated oil (Table IV) for human consumption. There has been a considerable interest in the domestic use of this oil. The oil-free meal has been used for food and feed purposes. But utilization of oil-free meal has been limited due to the presence of some antinutritional phenolic constituents in the meal[18]. These phenolic constituents are easily oxidizable into dark-green and brown substances. Among these constituents chlorogenic acid has been the principal phenolic compound in the sun-flower seed kernels. Other such factors reported in the kernels are caffeic and quinic acids but these are present in minor quantities. Thus for complete utilization of sun-flower seed for oil and food purposes detailed compositional analysis of the seeds was conducted.

Technically the part of the plant usually referred to as seed is a one seeded fruit which consists of a pericarp (hull) and the kernel. The kernel has a thin transparent paper-like covering which is the seed coat.

Data presented in Table XII show that the hulls constitute about one third of the kernel. The hulls mainly consists of fibrous matter (52 %) with lower percentage of protein (5.1 %) and oil contents (5.0 %). The greater proportion of fiber limits its use in feed products. However, certain physico-chemical treatments may make it fit for feed consumption.

Sun-flower seed kernels contain a higher proportion (53.5 %) of good quality (Table XII) polyunsaturated oil containing about 68 % linoleic acid (Table IV) which is desirable since it is one of the essential fatty acids. Protein contents of the kernel were found to be 26.5 % while the fiber contents were 2.12 % (Table XII). Phenolic constituents identified in kernels (Table XIII) were chlorogenic acid (1.68 %), caffeic acid (0.16 %) and quinic acid

(0.11 %). These components of the kernel have been reported to be the principal barrier to its utilization in food products[19]. The dehulled, defatted meal is light in appearance but when used in baked products the phenolic acids contribute a grey color to the product. Products obtained under alkaline conditions become dark green and brown in color. Thus removal of these acids from the meal is essential prior to its incorporation into food.

Main Uses of Sun-flower:

Almost entire production of sun-flower seeds in Pakistan is crushed for edible oil purpose. The oil being polyunsaturated is highly valuable for human consumption and after refining it is marketed as cooking oil. Inferior grade oil is used for industrial purposes, for soap manufacture and employed in blends with linseed and other drying oils in paints and varnishes.

Subsidiary Uses:[6]

In addition to oil extraction sun-flower seeds are also consumed as such. Larger seeds are roasted, salted and packaged whole for sale by confectioners. Large quantities of the seeds are also dehulled and kernels are roasted and sold as such. These kernels are also used in variety of sweets. Seeds of smaller size are also fed as such to poultry.

Secondary and Waste Products:[6]

1. The residue left after oil extraction is made into sun-flower cake and is used as a high grade protein supplement for livestock especially dairy cows and poultry. It is also used as a nitrogenous fertilizer.
2. Plant heads are also used as a dry season fodder for cattle.
3. Stover (morethan 50 % of plant portion) is usually left in the field to be ploughed in as manure or is burnt.
4. Hulls which constitute about 27 % of the seeds are utilized mainly as fillers in feed cakes and meals. They are also used in paper manufacturing.

SAFFLOWER

Safflower (Carthamus tinctorius L.) is one of the oldest cultivated oil-seed crops. Originally it was grown for the dye-stuff-carthamine. Now-a-days it is cultivated for extraction of poly-unsaturated oil and oil-free meal which is a valuable raw material for protein concentrates or isolates[20].

Although Indo-Pak sub-continent has been described as one of the centres of its ancient cultivation, it is only recently that it is only recently that it has been introduced as a commercial oil-seed crop in Pakistan. In the year 1978-79 it was planted over an area of 1310 hectares which has now been increased to 16,660 hectares for the year 1981-82 with an expected production of 11,330 tonnes. Two varieties spiny and spineless have been reported to be higher yielding and have higher oil contents.

Safflower is a profitable oil-seed crop as it yields a good quality oil and a meal of high nutritive value. The meal can be added into several food and feed products. Safflower protein isolate containing as high as 95 % protein has been incorporated in baked products and beverages[21].

Keeping in view the commercial cultivation of safflower in Pakistan four different varieties of safflower were included in the present studies. These were analysed for their proximate composition (Table XIV) for their evaluation as food and feedstuffs.

Safflower seed consists of a pericarp (hull), kernel and brown colored seed coat. Hulls make about 50 % of the seed and consist mainly of fiberous tissue (58-60 %). Protein and oil are among the minor components of the hulls (Table XV). Kernels contain 54-55 % oil and 22 to 30 % protein. Oils is highly unsaturated and contains a high proportion (75 %) of linoleic acid (Table IV). Oil contents of all the varieties show a similar pattern but protein contents vary considerably. This can be attributed to genetic variation, and agronomical and other agricultural practices.

Toxic Factor:

Like all other oilseeds safflower has also been reported to contain certain toxic factors. These are mainly the lignin glucosides which give bitter taste and cathartic activity to the oil-free meal[22]. Removal of these glucosides by chemical treatment results in the production of safflower meal fit for human consumption.

Main Uses of Safflower:

Safflower is mainly processed in Pakistan for its poly-unsaturated oil. The oil is refined and is marketed as cooking oil. Safflower oil has diversified uses in edible and industrial products. It is a drying oil and is used in varnishes, lacquers, pastel paints and alkyd resins where colour retention is important. Food industries of most of the countries also use this oil as a cooking oil, salad oil and as a constituent of margarine and mayonnaise[6].

Secondary and Waste Products[6]

1. Safflower seeds are processed both as decorticated and undecorticated seeds. The press cake thus obtained is used for cattle feeding and as manure.

2. Safflower protein and safflower protein isolate with as high as 95 % protein has been developed for human consumption. The isolate shows good dispersibility and exhibits desirable foaming and bread making properties. It has been successfully tried in baked products and beverages and has also been used for fortification of various dishes.

3. Carthamine, a yellow dye extracted from the florets was used for coloring purposes before the advent of aniline dyes.

4. Safflower hulls are used to provide bulk in high grade rations for beef cattle.

SOYBEAN

Soybean (*glycine max* (L) *merril*) has a history of more than 4000 years and has been employed as suitable food for diabetics as it contains comparitively smaller quantities of those carbohydrates which are available to human beings[23].

In Pakistan it has only recently been introduced as oil-seed crop and has successfully been grown in Sind and NWFP. It is being cultivated under the control of Ghee Corporation of Pakistan. During 1981 soybean was cultivated over an area of 6,250 hectares which is expected to increase upto 8,750 hectares during the coming years. Besides, Pakistan Agricultural Research Council (PARC) under FAO-TCP project has imported 40 tonnes of seed of tested varieties for distribution to generate a large scale seed base in the country.

Soybean is primarily a protein crop as it contains more protein than oil. However, addition of raw beans to a diet deficient in protein will not improve its biological value. Furthermore, raw soybean is not very palatable because of its texture and beany flavour. Soybeans when properly processed with moist heat shows marked increase in nutritive value which is almost equal to that of meat or milk protein.

Growth inhibitory effect of raw soybean has been attributed[24] to the presence of certain heat labile factors which inhibit proteolytic activity of digestive enzymes especially trypsin and stimulate protein synthesis in the pancreas which enhances pancreatic enzymes secretions. These effects lead to pancreatic hypertrophy and growth inhibition. Moist heat treatment converts raw bean into a product with good quality protein and improves its palatability. Thus heat treatment not only eliminates growth inhibitory effects and pancreatic hypertrophy but also transforms raw protein into a more readily digestible form.

Studies carried out in the PCSIR Laboratories have demonstrated that trypsin inhibitor is present in all the varieties tested (Table XVI) and it can be destroyed completely when oil free soybean meal is subjected to live steaming for 30 minutes (Table XVII). Other heat treatments (dry heating at 100°C for 60 minutes and autoclaving for 15 minutes) also reduce trypsin inhibitor to almost

non-detectable level but the product is of poor colour quality.

The data on proximate analysis of seven different varieties of soybean are reported in Table XVI. It is evident that soybean kernels form 86-90 % of the bean. The kernels are composed of two cotilydons and are rich in protein and oil.

Varieties under studies showed a great variations in their protein and oil contents. The amount of protein in kernels varied from 24.1 - 35.6 % with an average of 28.6 % and oil contents of the kernels varied from 22.5 to 30.2 %. The kernels contained 1.7 - 2.2 % fiber which makes it suitable for human consumption.

Fiber contents of the bean were higher than the kernels Table XVIII which suggested that dehulling is desirable before the bean meal could be incorporated into human diet. Ash contents of both the seeds and the kernels were higher than that of the hulls (Table XVIII) which indicates that most of the mineral matter was present in the kernels.

The proximate analysis data of the varieties reported provides substantial evidence that varieties grown in Pakistan have considerable potential for their use in human diet and other food products. Some commonly used food products such as cake, biscuits, "kabab", "barian", etc. have been prepared and evaluated at the PCSIR Lahore with promising results. This indicated that food products based upon soybean and soybean meal can be marketed in Pakistan.

Main Uses of Soybean

Soybean yields oil which in the refined and deodorized form is extensively used as cooking oil. About 106 tonnes of refined soybean oil was marketed as cooking oil by the Ghee Corporation of Pakistan during 1979-81. In other countries it is also used for salad dressing, and in mayonnaise. It also finds applications as packing oil for sardines, tuna and other kinds of fish. Confectionaries use soybean oil in their products such as sweets, frozen desserts and chocolate coatings. In its partially hydrogenated form, soybean oil is the major componant of practically all margarines and vegetable shortenings.

Refined soybean oil is used in paints and varnishes, surface coatings, printing inks, alkyd resins, soaps greases and lubricants[6].

Subsidiary Uses[6]

Soybeans are used mainly as a food crop in China, Japan and other East Asian countries. The seeds are consumed green, dry, sprouted, whole or split. Green seeds are used as a vegetable, roasted and salted seeds are used in cakes and candies. In Pakistan soybean has only recently been introduced and dry beans are used as pulses.

Secondary and Waste Products:[6]

1. Soy flour

A variety of secondary products are derived from beans or oil extracted meal. Soybean flour - a valuable source of protein is made both from beans and extracted beans. It is marketed in three forms, full-fat flour, low-fat flour and defatted flour and is used as an additive or extender to cereal flours which are protein deficient. It is also used in bakery products and beverages.

2. Soybean Milk

The protein of soybean bears a striking resemblance to casein. An artificial milk was prepared at PCSIR Lahore from soybeans, subjected to extensive biological and consumer evaluation tests. The process has been leased out to a commercial concern for exploitation. Cheese and youghart have also been produced from soymilk.

3. Soybean Meal

The residue left after oil extraction is a good source of protein and is used in the manufacture of animal feedstuffs, either alone or mixed with other components. It has also been converted into flour for human consumption.

4. Soy-lecithin

It is a phosphatide derived from soybean oil by degumming process. It is used in food industry as an emulsifier or dispersing agent, as an anti-oxidant for fats and as an aid in the blending of viscous fats and oils with dry flour and other ingredients.

5. Soy-Sauce:

It is a brown colored sauce prepared from boiled beans and roasted wheat flour after fermentation and digestion in brine solution.

6. Soybean is also utilized as a forage crop after curing or ensilage. It is also used as a legume to be ploughed in the fields as green manure.

Recommendations:

The following suggestion are made to increase production of vegetable oils in Pakistan.

1. Increase production of oil-seeds on scientific lines (right seeds under right environmental conditions).
2. Plantation and care after plantation of coco-nut and plam oil trees.
3. Increase proper storage facilities to avoid losses in term of quantity and quality.
4. Strength R & D and extension facilities.
5. Increase production of oil by applying latest technologies e.g. solvent extraction of oil from oil cakes.
6. Adoption of appropriate seed procurement policy.
7. Find proper use of the by-products.

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